PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project **Dworshak Dam Impacts Assessment and Fisheries Investigation**	
BPA project number	**8709900**
Contract renewal date (mm/yyyy)	**01/2000**
Multiple actions? (indicate Yes or No)	**No**
Business name of agency, institution or organization requesting funding **Idaho Department of Fish and Game**	
Business acronym (if appropriate)	**IDFG**
Proposal contact person or principal investigator:	
Name **Mailing address** **City, ST Zip** **Phone** **Fax** **Email address**	**Melo A. Maiolie** **PO Box 806** **Bayview, ID 83803** **(208) 683-3054** **(208) 683-3054** **mmaiolie@micron.net**
NPPC Program Measure Number(s) which this project addresses 10.3C, 10.3C.1, 10.3C.2, 10.3C.3	
FWS/NMFS Biological Opinion Number(s) which this project addresses **N.A.**	
Other planning document references **1. Dworshak Dam Mitigation Plan by the U.S. Army Corps of Engineers. This plan cites minimizing entrainment losses of fish as a primary mitigation measure. 2. 1998 Dworshak Reservoir Key Watershed Bull Trout Problem Assessment. This document cites restoring kokanee in Dworshak Reservoir as aiding the recovery of bull trout.**	
Short description Determines ways to minimize entrainment losses of fish into Dworshak Dam. Also, evaluates impacts to the kokanee population caused by drawdowns and routine operations of the dam.	
Target species **Kokanee**	

Section 2. Sorting and evaluation

Subbasin Lower Snake River Subregion, Clearwater Subbasin.

Evaluation Process Sort

CBFWA caucus		CBFWA eval. process		ISRP project type	
X one or more caucus		If your project fits either of these processes, X one or both		X one or more categories	
	Anadromous fish	X	Multi-year (milestone-based evaluation)		Watershed councils/model watersheds
X	Resident Fish		Watershed project eval.		Information dissemination
	Wildlife				Operation & maintenance
					New construction
				X	Research & monitoring
					Implementation & mgmt
					Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
N.A.		

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1990	Reservoir fishery documented.	Yes, reservoir was found to be capable of supporting a fishery of 140,000 angler hours with a harvest of 200,000 kokanee.
1993	Fishery objectives defined for waters of this type and productivity. Published in Rieman and Maiolie 1995.	We defined a biological objective of 30 to 50 adult kokanee per hectare as the “best” objective to optimize the fishery.

1993	Selector gates on dam successfully used to minimize entrainment losses during a year of low winter flow.	Yes, record high abundance of kokanee in the reservoir. Fishing was exceptional.
1994	Selector gates on dam utilized to avoid kokanee losses during winter of low flow.	Yes, new record high numbers of kokanee exceeding our objective. Fishing still exceptional.
1995	Selector gates again utilized to avoid kokanee losses during winter of low flow.	Yes, again a new record high population of kokanee in the reservoir which exceeded our objective. Catch rates and harvest very high, but size of fish was down. Benefits to other sportfish were seen. Exceeding the objective was not considered a major problem.
1995	Eighty foot drawdowns of reservoir to provide anadromous fish flows were found to have minimal impacts on the kokanee population.	Yes, kokanee survival for the year remained above 50% even with anadromous fish discharges.
1996	We successfully monitored kokanee abundance in the reservoir throughout the year and during a flood event when selector gates could not be used due to low pool elevation.	No. Kokanee population declined >95% when 1.3 million fish were lost through dam. All three age classes of kokanee dropped to new record lows. Fishing was terrible.
1997	Strobe light testing began. Kokanee repelled by lights during open water tests on free ranging fish.	Yes, kokanee were repelled in excess of 30 m (our sub-objective) from light source.
1998	Winter strobe light test conducted and found to be even more effective than during summer.	Yes. Kokanee repelled 100+ m, due to clearer water in winter. Result indicate that lights may be effective on the dam.
1998	Tests conducted with downward pointing strobe lights were found to repel kokanee.	Yes. Kokanee repelled 30 m vertically with light from above (sub-objective was 10 m). Test shows down-ward pointing lights could be used to repel fish from deep water.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1.	Increase the kokanee population to 30 to 50 adults/ha by reducing entrainment losses. This can be accomplished if annual survival rate for each year class of kokanee can be increased to 50%.		Test strobe lights, on-site, for their effectiveness at repelling kokanee from the intakes of the dam.

Obj 1,2,3	Objective	Task a,b,c	Task
		a.	We will test split-beam hydroacoustic gear for its ability to monitor kokanee entrainment near the dam.
		b.	The next task is to purchase strobe lights, rig wiring, construct a dock structure, and fabricate winch stantions for lifting lights.
		c.	Dock structure will be installed on wall of Dworshak Dam and secured with steel cable to keep it in a fixed location. Lights will be installed in front of only one intake during initial testing.
		d.	Floating dock structure will be tested during high flows for stability and to insure lights do not drift or hit trashracks.
		e.	Hydroacoustics will be used to monitor entrainment losses when lights are on (tests) and with lights off (controls).
		f.	Annually, we will estimate the kokanee population in the reservoir and calculate survival rates to determine the population effect of entrainment losses.
		g.	Provide biological information on entrainment to the Nez Perce Tribe for use in their modeling efforts to develop rule curves.
2.	Determine if annual operation of the dam causes >50% mortality to the kokanee population.	a.	Monitor kokanee population by hydroacoustics or trawling. And, conduct spawner counts in tributary streams.
		b.	Relate changes in survival rates to dam operation and flow year.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measurable biological objective(s)	Milestone	FY2000 Cost %
1.	01/1993	12/2005	Kokanee abundance maintained at 30-50 adults/ha.	X	67%

Obj #	Start date mm/yyyy	End date mm/yyyy	Measurable biological objective(s)	Milestone	FY2000 Cost %
2.	07/1998	12/2005	Kokanee annual mortality <50%.	X	33%
				Total	100%

Schedule constraints

Weather in the form of flooding could constrain this project. High flows and spilling at the dam could delay installation of floating structures. Odds of this happening are less than 10%.

Completion date

December 31, 2005.

Section 5. Budget

FY99 project budget (BPA obligated):	$ **120,000**

FY2000 budget by line item

Item	Note	% of total	FY2000 ($)
Personnel			85,000
Fringe benefits			30,000
Supplies, materials, non-expendable property			24,000
Operations & maintenance			10,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	For purchase of ten strobe lights, power converters, dock structures, and wiring.		80,000
NEPA costs			0
Construction-related support	U.S. Army Corps assistance with design and installation of floating docks.		15,000
PIT tags	# of tags:		0
Travel			4,000
Indirect costs	22.5% of budget not including capital outlay items.		37,000
Subcontractor			
Other			
		TOTAL BPA REQUESTED BUDGET	285,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		Total project cost (including BPA portion)	

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	299,000	314,000	330,000	346,000

Section 6. References

Watershed?	Reference
	Falter, C. M. 1982. Limnology of Dworshak Reservoir in a low flow year. United States Army Corps of Engineers. Walla Walla, Washington.
	Fredericks, J. P. 1995. Kokanee impacts assessment and monitoring on Dworshak Reservoir, Idaho. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 87-099, Portland, Oregon.
	Horton, W. A. 1980. Dworshak Reservoir fisheries investigations. Idaho Department of Fish and Game. Job Performance Report, Prepared for United States Army Corps of Engineers, Contract Number DACW68-79-C-0034, Boise.
	Horton, W. A. 1981. Dworshak Reservoir fisheries investigations. Idaho Department of Fish and Game. Prepared for United States Army Corps of Engineers, Contract Number DACW68-79-C-0034, Boise.
	Johnson, P. N., G.A. Frederick, and G.R. Ploskey. 1998 (in press). The effectiveness of strobe lights for vertically displacing juvenile salmon out of flow entering a 4.3 x 4.9 km filling intake at Hiram M. Chittenden Locks, Seattle. Anadromous Fish Evaluation Program, U.S. Army Corps of Engineers, Walla Walla, Washington.
	Maiolie, M. A. 1988. Dworshak dam impacts assessment and fisheries investigation. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 87-99, Portland, Oregon.
	Maiolie, M. A., D. P. Statler, and S. Elam. 1992. Dworshak Dam impact assessment and fishery investigation and trout, bass and forage species. Idaho Department of Fish and Game, and Nez Perce Tribe, Combined completion report, Prepared for Bonneville Power Administration, Project numbers 87-99 and 87-407, Portland, Oregon.

	Maiolie, M. A., and S. Elam. 1993. Dworshak dam impacts assessment and fisheries investigations. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 87-99, Portland, Oregon.
	Maiolie, M. A., and S. Elam. 1995. Dworshak dam impacts assessment and fisheries investigations project. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 89-99, Portland, Oregon.
	Maiolie, M. A., and S. Elam. 1996. Dworshak dam impacts assessment and fisheries investigations project. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 89-99, Portland, Oregon.
	Maiolie, M. A., and S. Elam. 1997. Kokanee abundance and distribution in Dworshak Reservoir and implications toward minimizing entrainment. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 89-99, Portland, Oregon.
	Maiolie, M. A., and S. Elam. 1998. Dworshak dam impacts assessment and fisheries investigations project. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 89-99, Portland, Oregon.
	Maiolie, M. A., B. Harryman, and B. Ament. 1999. Dworshak dam impacts assessment and fisheries investigations project. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 89-99, Portland, Oregon. (In Press)
	Mauser, G., D. Cannamela, and R. Downing. 1989. Dworshak Dam impact assessment and fishery investigation. Idaho Department of Fish and Game, Annual Progress Report, Prepared for Bonneville Power Administration, Project number 87-99, Portland, Oregon.
	Mauser, G., D. Cannamela, and R. Downing. 1990. Dworshak Dam impact
	McKinley, R.S. and P.H. Patrick. 1986. Use of behavioral stimuli to divert sockeye salmon smolts at the Seton Hydro-Electric station, British Columbia. Ontario Hydro Research Division. Toronto, Ontario.
	Nemeth R.S. and J.J. Anderson. 1992. Response of juvenile coho and chinook salmon to strobe and mercury vapor lights. North American Journal of Fisheries Management 12:684-692.
	Patrick, P.H. 1980. Responses of American eels to strobe light. Progress Report number 80-86-K. Ontario Hydro Research Division.
	Patrick, P.H. 1982. Responses of alewife to flashing light. Progress Report number 82-305-K. Ontario Hydro Research Division.
	Ploskey, G.R. and P.N. Johnson. 1997. Development of Behavioral technologies to improve the efficiency of surface collection and bypass structures on the Lower Columbia River. USAE Waterways Experiment Station, Stevenson, Washington.
	Rieman, B. E., and M. A. Maiolie. 1995. Kokanee population density and

	resulting fisheries. North American Journal of Fisheries Management 15:229-237.
	Skarr, D., J. Deshazer, L. Garrow, T. Ostrowski and B. Thornburg. 1996. Investigations of fish entrainment through Libby Dam, 1990-1994. Montana Department of Fish, Wildlife and Parks. Prepared for Bonneville Power Administration, Project Number 83-467, Portland, Oregon.
	Scheaffer , R. L., W. Mendenhall, and L. Ott. 1990. Elementary survey sampling, 4th edition. Duxbury Press, Belmont, California.
	Stober, Q. J., R. W. Tyler, C. E. Petrosky, K. P. Johnson, C. F. Cowman, Jr., J. Wilcock, and R. E. Nakatani. 1979. Development and evaluation of a net barrier to reduce entrainment loss of kokanee from Banks Lake. Fisheries Research Institute, Final Report, Prepared for United States Bureau of Reclamation, Contract Number 7-07-10-50023, University of Washington, Seattle.
	Winans, G. A., P. B. Aebersold, and R. S. Waples. 1996. Allozyme variability of Oncorhynchus nerka in the Pacific Northwest, with special consideration to populations of Redfish Lake, Idaho. Transactions of the American Fisheries Society 125:645-6663.
	Winchell, F.C., S.V. Amaral, E.P. Taft. 1994. Research update on fish protection technologies for water intakes. Final Report for Electric Power Research Institute. Palo Alto, California.
	Wydoski, R. S., and D. H. Bennett. 1981. Forage species in lakes and reservoirs of the western United States. Transactions of the American Fisheries Society 110:764-771.

PART II - NARRATIVE

Section 7. Abstract

Dworshak Reservoir was built in 1973 by the Army Corps of Engineers. This 718' high dam completely blocked the North Fork of the Clearwater River for anadromous fish and greatly changed the composition of the resident fishery. Our project goal is to improve the resident sport fisheries in the reservoir as partial mitigation for these impacts. Our objective is to minimize entrainment losses of fish into the turbine intakes and reservoir outlets so that a density of 30 to 50 adult kokanee/ ha can be maintained on an annual basis. Reducing entrainment losses of kokanee may also benefit other species by: lessening entrainment of other sportfish, providing more prey (small kokanee) for bull trout, and allow nutrients (in the form of kokanee spawners) to move upstream into the tributaries. We also propose to monitor the kokanee population annually and relate changes to the operation of the dam. This empirical information can then be used to assist in the development of rule curves for the reservoir.

Our methods are to test behavioral avoidance devices to see if kokanee, and other fish, can be scared away from the intakes to the dam. Strobe light testing was conducted off-site in 1997 and 1998. Kokanee avoided the strobe lights for the entire night and remained 30 to 40 m away from them in an open lake environment. Lights were found to be even more effective during winter

(the season of highest entrainment losses) and repelled kokanee in excess of 100 m. We propose to test the lights on-site in 2000. Lights will be installed in front of one turbine on the dam. Testing will be conducted during periods of low discharge when only one turbine is operating. Paired tests will be conducted between lights on (test group) and lights off (control group) to determine if entrainment losses can be reduced. Our expected outcome is to see a >50% reduction in fish entrainment during the tests. If we achieve this level of success, additional strobe lights will be purchased and installed in front of the remaining turbine intakes.

Section 8. Project description

a. Technical and/or scientific background

Dworshak Dam blocked the access to hundreds of miles of tributaries for anadromous fish spawning as well as flooded 54 miles of river habitat. The resident fisheries which developed in the reservoir were proposed to mitigate for some of these losses. Thus, our project to improve reservoir fisheries serves to mitigate losses "in place" but "out-of-kind".

Although twenty one species of fish are found in the reservoir, only three species provide important fisheries (Maiolie, et al. 1992). Of these species, kokanee have become the most dominant and have provided approximately 80% of the total catch (Maiolie et al. 1992). Kokanee are uniquely suited to this rapidly fluctuating reservoir since they spawn in the tributaries and live in the pelagic region. Unfortunately, losses of fish into the turbines and reservoir outlets (entrainment) has caused kokanee populations to vary widely. These entrainment losses were shown to be the main factor limiting kokanee populations in the reservoir (Maiolie and Elam 1995). During 1994, fluctuations in kokanee abundance and kokanee survival rates were found to correlate with the amount of water discharged from the dam. In 1996, kokanee entrainment exceeded 95% of the all of the kokanee in the reservoir (Maiolie and Elam 1998). Over 1.3 million kokanee were lost from the dam during a period of high discharge. In 1997, no age 1 or older kokanee were found in the reservoir during annual trawl sampling and counts of spawning kokanee in index streams dropped from 30,000 to 144 fish (Maiolie et al. 1997). Thus, controlling entrainment losses is a critical problem and it is the focus of this project. An ambitious 5 year stocking program began in 1998 to rebuild the population. Fry abundance in 1998 was increased to near normal levels by stocking 0.5 million fry. The kokanee population is expected to recover by the year 2000 if high entrainment losses do not occur.

The problem of entrainment losses is a critical concern throughout the Columbia Basin. Even more specifically, entrainment losses of kokanee has been a major problem in Libby Reservoir (Skarr et al. 1996) and Lake Roosevelt . If these losses could be minimized by a means such as strobe lights, then the operation of dams for flood control, power production, providing anadromous fish flows, etc. could be done with less of an impact on resident species. Thus, this project could help to increase the flexibility of dam operations, or to allow a better integration of resident and anadromous fish needs.

Strobe lights have achieved good success at moving fish in a number of different studies. Patrick (1982) found strobe lights worked well to divert alewife. Patrick (1980) found that American eels strongly avoided strobe lights with no behavioral adaptation over a 48 hour period. Nemeth and Anderson (1992) found that juvenile coho and chinook salmon avoided strobe light. At the York Haven Hydroelectric Project on the Susquehanna River, American shad were "strongly and consistently" repelled from the turbine intakes (Winchell et al. 1994). Ploskey and

Johnson (1997) found that strobe lights elicited consistent displacement of juvenile salmonids both vertically and horizontally. Field experiments at the Seton Hydro-Electric station in British Columbia tested the response of sockeye smolts to strobe lights at a current velocity approaching 1 m/sec. Strobe lights were found to be 56% effective at guiding downstream migrating fish (McKinley and Patrick 1986). The U.S. Army Corps of Engineers is currently conducting work with strobe lights at the Hiram M. Chittenden Locks in Seattle (Johnson et al. 1998, in press). Their work in 1998 shows that smolt entrainment into the locks was reduced 87% when the lights were turned on even though the water velocities were 5.5 feet/sec.

Our testing of strobe lights began in 1997 and is continuing in 1998. Testing was conducted off-site in lakes with high densities of kokanee. Results are very encouraging. Flash rates of 300 to 450 flashes/minute were highly successful at repelling kokanee in excess of 30 m (Maiolie et al. 1999, in press). Kokanee also did not become accustom to the lights, nor move closer to them, even after a whole night of operating the lights in the same location (Maiolie et al. 1999, in press). We tested the lights over shallow water (25 m deep) and deep water (300 m deep). Strobe lights worked equally well in both situations. We also found that strobe lights worked particularly well during winter which is the season of our highest entrainment losses. Tests during February 1998 documented that kokanee were repelled more than 100 m by the lights. Testing in 2000 needs to be conducted on Dworshak Dam to determine how kokanee react to the light under actual field conditions. This will allow us to study the effects of strobe lights on fish that are in a current of water and are schooled near the dam for a period of several months.

b. Rationale and significance to Regional Programs

How this project relates to the goals of the FWP can best be stated by comparing it to the criteria used by the CBFWA. The project does address specific Council Program measures specified in 10.3C. It is also consistent with management objectives of the State and Tribe. These objectives are spelled out in Idaho Fish and Game's 5 year management plan for Idaho. It also conforms to Council prioritization process according to program measure 10.1B. This measure gives a high priority to "resident fish substitution measures in areas that previously had salmon and steelhead, but where anadromous fish are now irrevocably blocked by federally operated hydropower development"; this is the case with Dworshak Reservoir. This project work provides a direct benefit to anadromous fish. The reservoir is lowered about 80 feet each summer to provide flows in the lower Snake and Columbia Rivers. By avoiding entrainment losses of fish, the continuation of these flows would be much more palatable to the public, and could be done with little impact to resident fish. Biological objectives of the Dworshak Research project have been developed (see section 4), but they have not been adopted into the Council's Program at this time. Data on entrainment losses, and methods to avoid them, will be used in the development of biological/integrated rule curves for this (and possibly other) storage reservoirs. Being able to avoid entrainment will make the biological rule curves for fish much more flexible. We are not, however, doing the actual development of the rule curves, that task was given to the Nez Perce Tribe. Our findings will hopefully benefit several species of fish within the reservoir. Kokanee are the primary species which will benefit. They are the largest resident fishery in the Clearwater drainage with up to 140,000 hours of fishing effort. But the project also provides direct benefit to non-target species. Avoiding entrainment losses of kokanee could also minimize the losses of cutthroat, rainbow trout or bull trout (the effect of strobe lights on these species has not been tested). An improved kokanee population provides forage for the reservoir's bull trout and smallmouth bass. Also, having 300,000+ kokanee run up tributary streams and die each fall could add significant nutrients to these stream systems.

Rational for the project: Entrainment losses of resident fish are a major concern in the Columbia Drainage. Entrainment losses of kokanee have been shown to be the main factor causing wide fluctuations in the abundance of kokanee in Dworshak Reservoir (from less than 2 adults/ha to 100 adults/ha). Strobe lights have shown positive benefits for other species such as Atlantic salmon, coho, chinook, and American eels (Patrick 1982, Nemeth and Anderson 1992 Winchell et al. 1994, Ploskey and Johnson 1997) . Strobe lights were found to repel kokanee to a distance of 30 m or more, with no habituation in our own studies. On site testing of strobe lights on Dworshak Dam is the logical next step in solving the problem of entrainment losses.

How this project furthers the goals of the FWP: One goal of the FWP was to "address the loss of salmon and steelhead in those areas permanently blocked to anadromous fish as a result of the construction and operation of hydroelectric dams". This project falls into this category. The native river habitat has changed into a fluctuating reservoir. This project attempts to improve sport fisheries on the native and introduced fish within this new habitat. It is also a principle of the FWP to "Protect, mitigate and enhance resident fish in hydropower system storage projects to the fullest extent practical from negative impacts associated with water releases". Our work on avoiding entrainment losses clearly does this.

c. Relationships to other projects

This project complements the work being done by the Nez Perce Tribe. They have two projects involving Dworshak Reservoir. The first is carrying out modeling work to develop rule curves for the reservoir. The second, is a project looking at the genetic integrity of cutthroat trout above the reservoir. Our projects have a similar goal of improving the reservoir's fisheries, but they each operate independently.

The U.S. Army Corps of Engineers is currently conducting work with strobe lights at the Hiram M. Chittenden Locks in Seattle (Johnson et al. 1998, in press). Their work in 1998 shows that smolt entrainment into the locks was reduced 87% when the lights were turned on even though the water velocities were 5.5 feet/sec. Their work and ours would help to demonstrate the potential for avoiding entrainment losses.

d. **Project history** (for ongoing projects)

Project number has not changed. Adaptive management implications: Our testing of strobe lights in 1997 was very successful. The next step is put this technology to use on the dam and learn how well it works on-site. This adaptive process would be far more successful and quicker than trying to learn all the answers by off site experiments and then decide how to install lights on the dam.

Project reports and technical papers: see full citations in section G for Maiolie 1988, Mauser 1988, Mauser et al. 1989, Mauser et al 1990, Maiolie et al. 1992, Maiolie and Elam 1993, Maiolie and Elam 1995, Maiolie and Elam 1996, Maiolie and Elam 1997.

Major results achieved: Early work showed that Dworshak Reservoir was capable of supporting a harvest of over 200,000 kokanee/yr, and also support fisheries for rainbow trout and smallmouth bass. Studies in the late 1980's to early 1990's showed that entrainment was controlling the kokanee population. Hydroacoustic studies in 1994 and 1995 tracked the movements of kokanee up and down the reservoir. They showed that kokanee congregated near the dam during winter and were much more vulnerable to entrainment in late winter and early spring. They also showed that kokanee were least susceptible to entrainment during the early fall when water releases for anadromous fish often take place. Research work in 1994-96 utilized the selector gates on the dam to try to avoid fish losses. Three record year classes were achieved, but in 1996 massive entrainment losses occurred when large amounts of water were released during late winter. Selective water withdrawal was impossible because the selector gates need to be raised when the reservoir elevation is low. Studies in 1997 showed that kokanee are strongly repelled by strobe lights at a flash rate of 300 to 450 flashes per minute and that no habituation to the lights occurred after an entire night of operation.

Past costs: 1988- $111,000 , 1989- $129,000, 1990- $153,000 , 1991- $137,000, 1992- $124,000, 1993- $145,000, 1994- $141,000, 1995- $133,000 , 1996- $169,000, 1997- $167,000, 1998- $180,000, 1999-$120,000.

e. Proposal objectives

Objective 1. Maintain a kokanee population of 30 to 50 adult kokanee/ha on an annual basis by reducing entrainment losses of fish. Rieman and Maiolie (1995) documented that densities in this range would optimize the kokanee fishery in Dworshak Reservoir.

Hypothesis: Entrainment losses of kokanee can be reduced by using strobe lights during the winter and spring to repel fish away from the turbine intakes.

Assumptions: Our assumption is that reducing entrainment losses will result in a high adult kokanee population and will not cause other forms of natural mortality to increase enough to mask this benefit.

Products: If strobe lights are successful, we would see at least a 50% reduction in number of fish entrained. This would allow the kokanee population to build to the objective of 30-50 adults/ha and increase fishing pressure to 140,000 hrs of angling/year. Also, at the end of our testing there will be strobe lights and platforms which could be used for a permanent installation on the dam. Knowledge gained on this project will be provided in annual reports.

Objective 2. Determine if annual operation of the dam causes >50% mortality to the kokanee population.

Hypothesis: Routine operation of the dam (as it currently exists) causes kokanee mortality to be sufficiently high that the fishery is impacted in most years.

Assumption: Massive, quick declines in the total kokanee population are due to entrainment losses and not another mortality factor.

Products: The main product will be the knowledge of how to avoid large-scale losses through Dworshak Dam, and possibly other dams as well. We will also learn the conditions which cause high entrainment losses. These findings will be written in annual reports and a final project completion report.

f. Methods

To date, all strobe light testing on kokanee was done off-site. This project will be our first experiment that is done on-site. To keep costs low, testing will be conducted in front of only one of the three turbine intakes. Testing will be conducted during winter which is a key time for entrainment losses because kokanee congregate near the dam during this season (Maiolie and

Elam 1997). Testing will be done when only one turbine is operating and when the selector gates on the dam can be set to withdraw water from the top 40 to 60 feet. This will allow testing to be conducted when the amount of area that would need to be "screened" by the lights is at its minimum.

Ten strobe lights will be suspended by a steel cable below a floating platform. Four of these lights will be suspended at the 30 foot depth and will be pointed horizontally at 90^{o} angles. Four more lights will be held at the 60 foot depth in a similar arrangement. The last two lights will be at the 60 foot depth and pointed downward. Off-site testing in 1998 used this 90^{o} arrangement of four lights with good success (Maiolie et al. 1998, in press). Testing with four lights during winter virtually eliminated kokanee from 3.1 ha of open lake within 20 minutes of starting the lights. Our hypothesis is that 10 lights can achieve similar results in front of the turbine intake where flows will be approximately 1,200 cfs.

We will evaluate the effectiveness of the strobe lights using hydroacoustics. A Simrad split-beam echosounder will be used to track fish in three dimensions as they approach the turbine intakes. The survey boat with the echosounding gear will be positioned approximately 100 m out from the dam, directly in front of the operating turbine. The transducer will be mounted on a pole and lowered 5 m below the surface. It will be pointed towards the turbine intake, and have a 3.5^{o} downward angle. With this arrangement, the acoustic beam will cover a 12 m diameter section of the intake; about 53% of the total intake area depending on selector gate setting. In a quiet environment, this echosounder is capable of tracking a 5 cm fish at a distance of 210 m. We will conduct preliminary testing near the dam to determine sensitivity of the hydroacoustic gear in the "noisy" environment near the dam.

Testing will use a Paired Student's T-test design. Each test with the lights flashing will be paired with a control sample with the lights turned off. First, a pilot study will be conducted to determine the appropriate duration for each test. One hour, three hour, and all night intervals will be tried. These preliminary tests will also provide estimates of the variance in entrainment rates so that sample sizes can be determined. A sample size will be chosen which will give us 90% confidence in determining a 40% change in kokanee entrainment. Our sub-objective for this test is to achieve a 50% reduction in kokanee entrainment under low flow conditions during winter. Testing will be considered successful at that point.

Should testing in 2000 prove successful, subsequent proposals will include funding for addition strobe lights to "screen" the two other turbine intakes. Testing will be conducted at higher discharge rates as more turbine intakes are "screened". Should strobe light tests on the turbine prove to be successful, studies will then begin on the reservoir outlets which are used under high flow conditions; 10,000 to 25,000 cfs.

Our second objective is to monitor kokanee abundance in the reservoir and relate abundance and survival rates to the operation of the dam that year. This will enable us to determine the effects of low or high water years, changes in dam operation, and drawdowns for anadromous fish flows. In the future, it will also tell us the "population effects" of operating the strobe lights on the dam.

Kokanee in the reservoir are monitored using three different methods: trawling, spawner counts, and hydroacoustics. These methods are described in Maiolie and Elam (1995). Trawling is conducted using a 28' diesel powered boat. It pulls a mid-water trawl net that is 10' x 10' at the mouth. The net is towed at a relative fast speed of 1.5 m/sec. Fifteen trawl hauls are made in the reservoir in a stratified random approach (Scheaffer et al. 1990). The sample size of 15 trawls is justified since this level of sampling was shown in the past to produce confidence limits of +/-

25%.

Spawner counts are made by walking up four tributary streams to Dworshak Reservoir on September 25 of each year (+ or - 2 days). These streams are walked from their mouth up to the end of the kokanee run. They have been conducted each year since 1983 and correlate well to our trawl estimates of the adult kokanee population. Thus, they serve as a check for our other population indices.

Kokanee estimates based on hydroacoustics are made using a Simrad split-beam echosounder. We use a stratified uniform sampling design where the reservoir is divided into three sections and transects across the reservoir are run at 2 mile intervals (Scheaffer et al. 1990). Data is analyzed using EP-500 software to provide fish density estimates. This approach has been shown to produce population estimates of kokanee that are within +/- 20% (90% confidence interval). Hrydoacoustics is the preferred method to estimate the kokanee population when the amount of debris in the reservoir is low. Trawling will be used when there are large amounts of debris in the water column.

g. Facilities and equipment

Currently on the project we have the most expensive pieces of kokanee monitoring equipment such as the 28' mid-water trawler, Simrad split-beam echosounder, and a 24' survey boat. We also have a crew that is trained to use these items. We have three vehicles and four computers. Additional trucks, computers, and equipment are available within the Department should we need to borrow them for short term usage. We are currently renting a field office for our researchers. Rent for this facility is shared with another BPA funded project to keep costs down.

There is a considerable amount of other equipment within the Department of Fish and Game which is available for our project to borrow. The Department also can provide volunteer workers, administrative and computer help, manpower, equipment and storage space, bunk facilities at the Clearwater fish hatchery, and expertise on many subjects. The Department's accounting section keeps track of our billing and our budgets. The Department also provides the assistance of a technical typist.

h. Budget

Personnel- The amount here covers the principal investigator, technicians, and research biologist.

Fringe benefits- These are determined by the state of Idaho and vary from 11 to 36% depending on position.

Supplies, materials, non-expendable property- Much of materials and supplies for FY 2000 is for hardware associated with the construction of docks to hold strobe lights, and the needed wiring and cabling to keep the structure on the back of the dam.

Operations & maintenance- covers expenses associated with operating two boats, three trucks, and an office.

Capital acquisitions or improvements (e.g. land, buildings, major equip.)- The biggest capital outlay item will be the purchase of 10 strobe lights and their power converters and wiring. Another large purchase is for the dock structure that holds the lights, generator, and winches that raise and lower the lights.

NEPA costs- none.

Construction-related support- We have money in this category to get the help of the Army

Corps of Engineers with the design and installation of the dock structure. This may also cover the cost of using their large cranes to lower equipment into place behind the dam.
PIT tags- none.
Travel- travel costs were calculated at the State's current rate of $20/day.
Indirect costs - set by the state of Idaho, currently at 22.5%, (rate for FY 2000 is currently unknown, but expected to be similar).
Subcontractor- none.
Other - none
Total BPA requested budget- The total of $285,000 is an increase of $165,000 from FY 1999. This increase is to cover the higher costs associated with the on-site strobe light testing; purchase of strobe lights, construction of and installation of docks, and hiring of one additional person.
Outyear costs- Our outyear costs are the same basic budget with a 5% increase for inflation. The reason for the same budget is that in each additional year the test will be expanded to include additional turbine intakes and then the reservoir outlets (all of which is pending the successful screening of the first turbine intake).

Section 9. Key personnel

The principal investigator on the project is Dr. Melo A. Maiolie, Principal Fishery Research Biologist. He has been working for the Department of Fish and Game for 11 years, with 8 of those years in fisheries research. He received a B.S., M.S. and Ph.D. in Fisheries and Wildlife Management from West Virginia State University (1973), and Colorado State University (1977,1985). Dr. Maiolie works half time on this project and half time on the Lake Pend Oreille Fishery Recovery Project. He has been working on reservoir projects, and projects involving the federal hydropower system for over 16 years. His Ph.D. work was on the impacts of a pumped-storage power plant on the fish community of a high mountain lake in Colorado. Examples of his publications can be seen in the literature cited section of this proposal.

Bill Harryman, Sr. Fisheries Technician, works 6 months per year on this project. Bill has been with the Department of Fish and Game for 13 years. He graduated from the University of Idaho in 1986 with a B.S. in Fishery Resource Management and a B.S. in Wildlife Resource Management. His areas of expertise include: conducting hydroacoustic population estimates, trawling, and has been involved with strobe light testing for the last 2 years. Bill is certified scuba diver and experienced field technician.

Bill Ament, Sr. Fisheries Technician, works 6 months per year on this project. He has been with the Department of Fish and Game for 3 years. Bill worked for 2 years on both the rainbow trout and burbot portion of the Kootenai River research project. Prior to this, he worked for 1 year on Lake Pend Oreille doing kokanee population monitoring. He received a B.S. in Wildlife and Fisheries from the University of Idaho in 1977. His particular expertise on this project include: mid-water trawling, scuba diving, handling large boats, and has been involved with strobe light testing for the last year.

A full time research biologist will be hired on this project in 2000. Researchers for Idaho Fish and Game nearly always have a Master's degree in fishery science. Background of this person is currently unknown.

Section 10. Information/technology transfer

The findings of this project will be distributed several ways. First, quarterly reports will be mailed to interested parties and placed on the Department's internet home page for immediate access. Next, annual reports will be written and are available from the BPA library. We also present the findings of our project at review meetings held by BPA, when they occur. Presentations on our research work will be given at meetings of the Idaho Chapter of the American Fisheries Society about every other year. Recommendations from our project are discussed directly with the Regional Fishery Managers in the State to determine whether regulation changes or changes in management direction are needed. Lastly, we present an update of our work annually at the International Kokanee Workshop. Every fourth year, we host the International Kokanee Workshop and showcase our projects. At the completion of the project one or more journal articles will be written.

Congratulations!